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Abstract

Purpose: This scoping review discusses how Bug-In-Ear (BIE) technology has been used to coach teachers and pre-service teachers in special education, general education and Initial Teacher Education (ITE). The purpose of the review is to identify the range of practices in implementing BIE technology and the potential impacts on teachers, learners, coaches and professional learning and development (PLD) providers.

Design/methodology/approach: The Prisma framework guided the structure of the scoping review. Four leading educational database searches informed initial results. Peer review ensured that inclusion and exclusion requirements were rigorously followed. Two screenings, a hand search and snowballing found 20 relevant studies for review.

Findings: BIE coaching is a cost-effective approach to support the development of teachers and pre-service teachers, with the potential to improve learner outcomes. Delivering coaching remotely yields the widest range of benefits for PLD providers. Technology issues persist, therefore simple approaches work most effectively. There are opportunities to explore coaching attributes required for BIE coaching and how BIE feedback can differ from in-person feedback.

Practical implications: PLD should be based on available resources; however, it is possible to train participants to use BIE in a short amount of time. Predetermined prompts should be co-constructed between the coach and the teacher. Prompts should be delivered within 3-5 seconds of the teaching behaviour and consist of positive, corrective, questioning and goal-orientated statements.

Originality: This is the first evidence-based review of BIE coaching that highlights effective practices in special education, general education and ITE. This review also explores how BIE coaching is used with teachers, which has not been covered in detail.

Keywords: Bug in ear, initial teacher education, professional learning and development, coaching, mentoring, performance feedback, technology.

Introduction

This article presents a scoping review of research on the use of Bug-In-Ear (BIE) coaching with teachers, paraprofessionals and pre-service teachers in general education, special education and ITE. A key characteristic of BIE technology is the ability to modify how feedback is provided and acted upon. The coach, visiting lecturer or mentor teacher (subsequently referred to as coach) has a direct and discreet link to the teacher via an in-ear speaker and can communicate in real time using either in situ or remote virtual feedback via video observation and a BIE device, with the latter having a minimal effect on the flow of the teaching episode (Horn *et al.*, 2020; Scheeler *et al.*, 2010). The requirement to consistently receive high quality practice related feedback and coaching shapes and develops the careers of all educators, it provides the means to understand what is working well and what needs to be improved (Cash *et al.*, 2022). Research has demonstrated that the timing of performance feedback is critical and often dependent on the task being performed (Hattie and Timperley, 2007). Conventionally, an educator receives post lesson feedback due to the constraints of a traditional classroom observation environment (Scheeler *et al.*, 2006); this is known as deferred feedback. However, Kulik and Kulik (1988) found that deferred feedback is not as effective as immediate feedback for improving teaching performance. BIE coaching enables immediate feedback and can scaffold the concept of ‘reflection-in action’ (Schön, 1987) by supporting the practitioner to notice actions and respond accordingly in the moment, as suggested by van Es and Sherin (2002). The COVID-19 pandemic restricted the physical access of many universities and PLD providers to schools;

however, educators still required coaching and support to navigate the challenges (Kidd and Murray, 2020). It is therefore important that practices in BIE coaching are evaluated as we move into hybrid approaches to education.

Definition of terms

In this study we defined BIE as a tool to deliver immediate performance-based feedback to a practicing teacher in real time. This could be delivered either in-situ or remotely. Coaching is a formative professional collaboration focussed on the ongoing dialogic development of teacher practice to influence learner outcomes (Lofthouse, 2019). Feedback is defined as the process where recipients make sense of comments on performance to inform future actions (Carless and Boud, 2018).

Rationale

High quality feedback - BIE coaching

There are expanding opportunities regarding effective feedback delivery to support either a directive feedback approach or a questioning stance that can support the receiver to notice more about their practice (Fernández *et al.*, 2020). BIE feedback has grown in popularity with the affordability of mobile technology, and the reliability of ubiquitous internet connections. Scheeler (2012) highlights compelling arguments to justify the use of immediate feedback via BIE technology. One advantage is a reduction of teachers perpetuating negative habits and ineffective practice which can permanently be embedded in their teaching. BIE feedback can disrupt this cycle by supporting teachers to modify teaching techniques immediately.

Objectives

The objective of this study was to provide a scoping review of using BIE technology when providing feedback to teachers, pre-service teachers and paraprofessionals, such as those

who support learners with dyslexia. The strategies implemented through BIE and the impacts for teachers and learners are also investigated. While there have been literature reviews with BIE as a focus they have been within the context of medicine (Gallant and Thyer, 1989; Tropea *et al.*, 2019) or special education (Sinclair *et al.*, 2020). Literature reviews in wider educational contexts have only mentioned BIE as a strategy (Kretlow and Bartholomew, 2010; Nesje and Lejonberg, 2022) rather than situating it as the main focal point. A scoping review was selected over a literature review as scoping reviews are an appropriate method to review a wide range of literature regardless of study design.

Methods

A scoping review follows a systematic approach to examine the extent, nature, and range of research activity on a particular topic or question and attempt to identify gaps in the existing research (Arksey and O'Malley, 2005). Scoping reviews are useful when investigating an emerging area with a wide range of approaches yet to be discovered (Levac *et al.*, 2010). This scoping review used the PRISMA-ScR (Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews) framework (Tricco *et al.*, 2018) to inform the structure of the article.

Eligibility criteria

Peer reviewed articles published between 2000 and 2022 were eligible for this scoping review. There is literature available prior to 2000, however the technology has advanced considerably since the turn of the century. Bluetooth technology was introduced in 2000, improving the functionality and connectivity of BIE devices. This was enhanced further with the development of Bluetooth 2.0 in 2004 (Harte, 2004). Empirical studies with qualified primary,

secondary and tertiary educators and paraprofessionals and a participant sample including in-service and pre-service teachers were screened for inclusion. Paraprofessionals were included in the study as there is substantial literature focussing on special education where paraprofessionals have an important role. Excluded from the study were non-peer reviewed and non-empirical studies, dissertations and reports, medical or health-based research and grey literature. Grey literature was excluded as it is not a product of the peer review process. It is challenging to replicate search techniques due to the complexity of searching and filtering grey literature (Lawrence *et al.*, 2015). Identification is time-consuming as grey literature often has no abstract; therefore, the whole document must be read to determine inclusion (Benzies *et al.*, 2006). Several commercial operations are interested in BIE technology and the educational coaching market. Introducing these papers into the analysis could have created a bias towards the tool's benefits and how it should be used.

Information sources

The following databases were used for the literature search on 23rd August 2021:

- 1) Web of Science
- 2) EBSCOHOST Megafire Ultimate: Academic Search Ultimate, Applied Science & Technology Source Ultimate, Education Research Complete, E-Journals, ERIC, Humanities Source Ultimate
- 3) ProQuest One Academic
- 4) Scopus

Search

Appendix A lists the search terms and a search example in ProQuest One Academic.

Searches were filtered to return full text, peer reviewed journal articles in English only. The

search included all articles published from 2000 until the search date which was 23rd August 2021. The search strategy was peer reviewed by the university librarian. The initial search returned 701 articles. 7 from EBSCOHost, 123 from ProQuest One Academic, 133 from Scopus and 438 from Web of Science. 21 duplicates were removed to bring the total records required for screening to 680.

Selection of sources of evidence

The abstracts and titles were exported to EndNote X9 and processed for phase one screening where both authors checked for suitability. Articles were excluded if they were not using BIE technology to receive feedback while teaching, were in non-school based settings or were grey literature. Appendix B shows the process through the PRISMA flow diagram.

Data charting process and data items

The table in appendix C includes relevant information for each of the 20 reviewed articles. The authors reviewed their allocation of articles and updated the table on a collaborative Word document in OneDrive. Data was verified using comments to identify any uncertainties in evaluating the articles. For each article, the table shows the author(s), year, title/journal, context, study design, communication/setup and evaluation. The context column highlights the educational domain as well as the research participants. The context is important to note as most research on BIE technology has been in small cohort special education classes; it was important for the authors to understand if coaches in various contexts utilised different communication setups. The communication/setup was relevant as these would highlight the range of practices in providing BIE feedback. The evaluation column indicated the impacts on coaches, mentors, teachers and students. The text in the table and the research questions from each study were coded in NVivo to generate themes.

Results

Characteristics of sources evidence

The context and type of participant was summarised in each study. From the 20 selected articles 12 were situated in special education and eight were in general education. Seven supported pre-service teachers, 11 in-service teachers and two paraprofessionals. The numbers of participants ranged from one teacher and one coach (Cooper *et al.*, 2018) to 28 teachers and one coach (Rock *et al.*, 2013); this particular study was a follow up investigation from Rock *et al.* (2009), which was the broadest study with 12 different schools in six school districts across five counties in the southeastern United States.

Nineteen different strategies were implemented via BIE coaching. The studies measured a range of outcomes, with 23 focussing on teacher outcomes and 13 on learner outcomes. 14 studies used single subject multiple baseline design with varying applications of ABA withdrawal. Two studies also used experimental design, two design based and one that used mixed methods sequential explanatory strategy. One study did not discuss study design. Ten studies used a social validity survey to discover participant sentiment and attitude towards the intervention of BIE coaching. Data collection methods and instruments covered observations, anecdotal notes, learner engagement data, semi structured interviews, surveys, focus groups, keyword logs, coding at time intervals, frequency counts, Teacher Performance Rate and Accuracy Scale (Ross *et al.*, 2005), and the Discrete Trial Teaching Evaluation Form (DTTEF). Several studies also used video recordings to support the coding (O'Brien *et al.*, 2021; Rock *et al.*, 2009, 2013; Rosenberg *et al.*, 2020). It is important to note that half of the studies commented explicitly on the cost effectiveness of using BIE. This is mainly due to the time and money saved in physical travel (Cooper *et al.*, 2018; McKinney and Vasquez, 2014; Rosenberg *et*

al., 2020) and the low cost of the tools involved (Coogle, Ottley *et al.*, 2016; Rock *et al.*, 2009; Scheeler *et al.*, 2012). The results are reported following the columns in the data charting table (appendix C); range of practices for BIE coaching and strategies and impacts for teachers and learners.

Range of practices for BIE coaching

The articles were coded using NVivo and our analysis highlighted five themes in the research related to the range of practices; (1) ‘technology set up’, covering the practical implementation of the tools used to provide BIE coaching, (2) ‘training and PLD, explaining how the tool was introduced to the participants, (3) ‘communication prompts’ which code the specific interactions when communicating using BIE coaching and (4) ‘frequency of prompts’ which detail when and how often the feedback is provided and (5) ‘timing of prompts’ details when the feedback was provided. Table I lists the themes in the left column and the studies that identified each theme in the right column. Studies with an asterisk did not find a positive outcome in relation to the theme.

Theme	Studies identifying the theme
<i>Technology setup</i>	
Remote provision	(Cheek <i>et al.</i> , 2019; Coogle, Rahn, <i>et al.</i> , 2016; Cooper <i>et al.</i> , 2018; Garland and Dieker, 2019; McKinney and Vasquez, 2014; O’Brien <i>et al.</i> , 2021; Randolph <i>et al.</i> , 2020; Rock <i>et al.</i> , 2009, 2013; Rosenberg <i>et al.</i> , 2020; Scheeler <i>et al.</i> , 2010, 2012; Stahl <i>et al.</i> , 2016)
In-situ provision	(Coninx <i>et al.</i> , 2013; Goodman <i>et al.</i> , 2008; Owens <i>et al.</i> , 2020; Ploessl & Rock, 2014*; Scheeler <i>et al.</i> , 2006; Scheeler & Lee, 2002; Sharplin <i>et al.</i> , 2016)
2-way mirror	(McKinney and Vasquez, 2014)
Webcam, Apple MacBook Pro Laptop, Skype, Call recorder (Cheek <i>et al.</i> , 2019)	(Cheek <i>et al.</i> , 2019; Ploessl and Rock, 2014; Rock <i>et al.</i> , 2009, 2013; Scheeler <i>et al.</i> , 2012)
Adobe Connect and Bluetooth	(Garland and Dieker, 2019)

Theme	Studies identifying the theme
Motorola two-way radios T4500, earbud wired to a receiver.	(Goodman <i>et al.</i> , 2008)
Swivl, iPad/iPod mini or Apple MacBook, Google hangouts (O'Brien) /Zoom, screen recorded using Camtasia (O'Brien <i>et al.</i> , 2021).	(O'Brien <i>et al.</i> , 2021; Randolph <i>et al.</i> , 2020; Rosenberg <i>et al.</i> , 2020)
<i>Training and PLD</i>	
15-30 minutes 1:1 training session	(Cheek <i>et al.</i> , 2019; Rosenberg <i>et al.</i> , 2020; Scheeler and Lee, 2002)
2hr Training session	(Goodman <i>et al.</i> , 2008; O'Brien <i>et al.</i> , 2021)
5-minute training video	(Randolph <i>et al.</i> , 2020; Scheeler <i>et al.</i> , 2012)
<i>Communication Prompts</i>	
Specific keywords or phrases	(Coninx <i>et al.</i> , 2013; Cooper <i>et al.</i> , 2018; McKinney and Vasquez, 2014; Scheeler <i>et al.</i> , 2006, 2010, 2012; Scheeler and Lee, 2002)
Adhoc statements	(Coninx <i>et al.</i> , 2013*; Sharplin <i>et al.</i> , 2016)
Corrective	(Scheeler <i>et al.</i> , 2006; Scheeler and Lee, 2002)
Affirmative or corrective	(Coogle, Rahn, <i>et al.</i> , 2016; McKinney and Vasquez, 2014)
Affirmative, corrective, or prompts/questioning.	(O'Brien <i>et al.</i> , 2021)
Instructing, corrective, encouraging, and questioning.	(Ploessl and Rock, 2014; Rock <i>et al.</i> , 2009, 2013)
Specific, constructive, and purposeful	(Rosenberg <i>et al.</i> , 2020)
Specific, positive and corrective	(Scheeler <i>et al.</i> , 2010, 2012)
4:1 praise to correction ratio	(Cheek <i>et al.</i> , 2019*; Rock <i>et al.</i> , 2013)
<i>Frequency of prompts</i>	
1 per minute	(Coogle, Rahn, <i>et al.</i> , 2016; Cooper <i>et al.</i> , 2018; Randolph <i>et al.</i> , 2020)

Theme	Studies identifying the theme
<i>Timing of prompts</i>	
Delivered within 3-5 seconds	(Coninx <i>et al.</i> , 2013; Randolph <i>et al.</i> , 2020; Scheeler <i>et al.</i> , 2006, 2010, 2012; Scheeler and Lee, 2002)

*Indicates the study did not find a positive outcome in relation to the theme

Table I. Range of practices for BIE coaching

Strategies and impacts for teachers and learners

Research questions from the studies were coded using NVivo, they were then aligned to the ‘evaluation’ column in appendix C to highlight the impact. Table II shows the three themes that were developed; (1) the use of BIE to implement a particular teaching strategy, for example a comprehension strategy, or behaviour specific praise; (2) a specific teacher outcome; (3) and a specific learner outcome.

Theme	Studies identifying the theme
<i>Teaching strategy</i>	
Opportunities to respond	(Cheek <i>et al.</i> , 2019; Garland and Dieker, 2019)
Frequency and type of questions asked	(Cheek <i>et al.</i> , 2019)
Use of modelling strategies (self-talk, parallel talk, and expansions)	No positive outcome
Completed TTC trials	(Garland and Dieker, 2019; Scheeler <i>et al.</i> , 2006, 2010, 2012; Scheeler and Lee, 2002; Sharplin <i>et al.</i> , 2016)
Increase accuracy and delivery rates of Learn Units (LU’s)	(Goodman <i>et al.</i> , 2008)
Discrete trial teaching procedures	(McKinney and Vasquez, 2014)
Implementation fidelity in facilitating a self-monitoring strategy	(Owens <i>et al.</i> , 2020)

Theme	Studies identifying the theme
Increase delivery of (Behaviour specific praise) BSP	(Randolph <i>et al.</i> , 2020)
Incidental teaching as an instructional strategy	(Rosenberg <i>et al.</i> , 2020)
Video-based reflection and teacher candidates' use of evidence based practice (EBP)	(O'Brien <i>et al.</i> , 2021)
<i>Teacher outcome</i>	
Cognitive load	(Coninx <i>et al.</i> , 2013)
Increase of positive feedback and decrease of negative feedback by the teacher	(Cooper <i>et al.</i> , 2018; Rock <i>et al.</i> , 2009)
Effective strategies for student engagement	(Cooper <i>et al.</i> , 2018)
Maintenance	(Garland and Dieker, 2019; McKinney and Vasquez, 2014; Owens <i>et al.</i> , 2020; Randolph <i>et al.</i> , 2020; Scheeler <i>et al.</i> , 2006)
Implementation of DTT procedures	(McKinney and Vasquez, 2014)
EBP	(O'Brien <i>et al.</i> , 2021)
Social validity with video-based reflection intervention	(Coogle, Rahn, <i>et al.</i> , 2016; McKinney and Vasquez, 2014; O'Brien <i>et al.</i> , 2021; Ploessl and Rock, 2014; Randolph <i>et al.</i> , 2020; Rosenberg <i>et al.</i> , 2020; Scheeler <i>et al.</i> , 2006, 2010, 2012; Scheeler and Lee, 2002)
Implementation fidelity within the tiered coaching model	(Owens <i>et al.</i> , 2020)
Co-teachers plan and carry out co-teaching models, support good implementation of classroom assistant.	(Ploessl and Rock, 2014)
Increase growth mindset, confidence, resilience and reduce stress.	(Sharplin <i>et al.</i> , 2016; Stahl <i>et al.</i> , 2016)
Increase a specific effective teaching technique (i.e., completion of three-term contingency [TTC] trials, individual goals or professional practice)	(Cheek <i>et al.</i> , 2019; Coninx <i>et al.</i> , 2013; Coogle, Rahn, <i>et al.</i> , 2016; McKinney and Vasquez, 2014; O'Brien <i>et al.</i> , 2021; Randolph <i>et al.</i> , 2020; Rock <i>et al.</i> , 2009, 2013; Rosenberg <i>et al.</i> , 2020; Scheeler <i>et al.</i> , 2006, 2010, 2012; Scheeler and Lee, 2002; Sharplin <i>et al.</i> , 2016)
PST and students using BIE wireless technology report being distracted by the device	(Coogle, Rahn, <i>et al.</i> , 2016; Cooper <i>et al.</i> , 2018)

Theme	Studies identifying the theme
PST and students using BIE wireless technology report not being distracted by the device	(Cheek <i>et al.</i> , 2019; Scheeler <i>et al.</i> , 2012; Scheeler and Lee, 2002)
<i>Learner outcome</i>	
Listening comprehension for students	(Cheek <i>et al.</i> , 2019)
Engagement in comprehension instruction	(Cheek <i>et al.</i> , 2019)
Behavioural outcomes/ students' on-task behaviour impact (i.e., benefit or disrupt)	(Cooper <i>et al.</i> , 2018; Owens <i>et al.</i> , 2020; Rock <i>et al.</i> , 2009)
Rate of correct answers among students/ Students' responses to teacher candidates'	(Cheek <i>et al.</i> , 2019; Garland and Dieker, 2019; O'Brien <i>et al.</i> , 2021; Scheeler <i>et al.</i> , 2006; Scheeler and Lee, 2002)
Elicit students' expressive language	Difficult to evaluate with a wide range of variables.
Student learning self-advocacy statements to increase student use of target statements.	(Rosenberg <i>et al.</i> , 2020)
Completion of three-term contingency trials by PST result in a change in percentage of correct responses by students	(Scheeler <i>et al.</i> , 2006; Scheeler and Lee, 2002)
Student engagement	(Cheek <i>et al.</i> , 2019; Cooper <i>et al.</i> , 2018; Garland and Dieker, 2019; Owens <i>et al.</i> , 2020; Ploessl and Rock, 2014; Rock <i>et al.</i> , 2009)

Table II. Strategies and impacts for teachers and learners

There were 2 studies where a positive outcome could not be identified in relation to the themes that were developed through coding.

Synthesis of results

Range of Practices for BIE coaching

BIE coaching provides an unobtrusive approach to delivering feedback (Randolph *et al.*, 2020). Benefits are enhanced when coaching is delivered remotely to teachers in hard-to-access locations, minimising costs in travel and time for the coach (Scheeler *et al.*, 2012). Technology

advancements have enabled a progression in how the feedback has been delivered; a wireless FM system (Scheeler and Lee, 2002) used from the back of the classroom has developed into a more sophisticated approach. The most recent technology implementations used iPods or iPads set up as cameras in the classroom, connected via Bluetooth to enable two-way communication between the teacher and the BIE coach. The lesson was often recorded using a screen recorder encouraging post-lesson reflection (Rosenberg *et al.*, 2020). Technology issues persist; however simplifying the technology could be a solution, Sharplin *et al.* (2016) suggest that SWIVL© may be an unnecessary complication. Different contexts did not require different technology applications as they were similar throughout all studies regardless of being in a primary, secondary, or tertiary setting.

Training and PLD for BIE coaching was varied with some studies providing as little as 5 minutes (Randolph *et al.*, 2020; Scheeler *et al.*, 2012) and others up to a 2 hour training session (Goodman *et al.*, 2008; O'Brien *et al.*, 2021). The short training sessions from Randolph *et al.* (2020) were very cost effective; however the longer lead-in times found in other studies could mitigate challenges with technology. Studies also indicated that the coaches were often expert practitioners in the first place (Coninx *et al.*, 2013; Sharplin *et al.*, 2016) and suggest that coaches beyond this expert group would require further (Rosenberg *et al.*, 2020; Scheeler *et al.*, 2012; Scheeler and Lee, 2002). Therefore, PLD for using BIE coaching should be based on the resources and time available but be provided for everyone involved.

Examples of phrases and keywords	Study
“Remember to praise,” “correct the error,” and “be specific”	(Garland and Dieker, 2019)
Stay with [name],” “Good praise,” “Remember to reinforce,” “Positive reinforcement,” “Good response,” and “Stick with him.”	(Scheeler <i>et al.</i> , 2010)
“Nice job!”	(Rosenberg <i>et al.</i> , 2020)

Examples of phrases and keywords	Study
(a) "Give feedback on (name behaviour)," when the teacher failed to deliver any consequence to a student's response, therefore not completing the three-term contingency trial; (b) "Correct error by (name the correction, e.g., "doing a fact correction," or "doing a rule correction")," if the correction was attempted but completed incorrectly; or (c) "Good feedback to (name of student)."	(Scheeler and Lee, 2002)
"This is a rule or concept error. Use a procedural correction." (b) "This is a fact error. Use a fact correction." (c) "Reinforce correct response." "Repeat question." "Remember to praise." "Nice work correcting the error."	(Scheeler <i>et al.</i> , 2006) (Scheeler <i>et al.</i> , 2012)
'Single question'= Ask one question at a time, separate multiple questions into single questions. 'Clarify'= Say, "I will rephrase that," and then ask single question. 'Correction'= Provide a correction for incorrect response. 'Reinforce'= Provide specific and positive praise statement, such as "yes, 4 is right." 'Keep teaching'=Go back to teaching lesson objective. 'Ask a question'=Start or continue asking questions about the concept. 'Slow down'=Give pauses or slow down instruction. 'Speed up'=Ask more questions or pick up the pace of instruction.	(Goodman <i>et al.</i> , 2008)

Table III. Examples of phrases and keywords

Most coaches in studies used specific phrases or key words to provide feedback (Coninx *et al.*, 2013; Cooper *et al.*, 2018; McKinney and Vasquez, 2014; Scheeler *et al.*, 2006, 2010, 2012; Scheeler and Lee, 2002). There was general agreement that feedback should be delivered between 3-5 seconds after the target behaviour or interaction was observed (Coninx *et al.*, 2013; Randolph *et al.*, 2020; Scheeler *et al.*, 2006, 2010, 2012; Scheeler and Lee, 2002). The communication prompts evolved from the work of Scheeler *et al.*, (2006, 2010, 2012) who advocate for specific, positive, immediate, and corrective feedback and Rock *et al.* (2014, 2009, 2013), who suggest prompts which are instructing, correcting, encouraging, and questioning. Slight variations exist with Rosenberg (2020), who includes 'purposeful', but it could be argued that this is in line with the 'specific' feedback from Scheeler's recommendations. Table III lists the communication prompts that were used in the studies.

The literature within the studies consistently references the work of Scheeler *et al.* (2004), who evaluate that feedback to teachers should be immediate, systematic, corrective, and positive. More recently, Rock (2019) suggested that when implementing *eCoaching* with BIE the users should (a) distinguish between various types of feedback; (b) determine the timing in

which that feedback should be delivered; (c) have an established procedure for systematically scaffolding feedback; and (d) include goal monitoring. This reflects the approaches initiated by (O'Brien *et al.*, 2021) with the inclusion of goal setting.

There is currently very little research on the range of practices applied in BIE feedback and how this should differ from in person feedback (Rosenberg *et al.*, 2020). However, in the research from Coninx *et al.*, (2013) they discovered that any feedback should be as short as possible due to the simultaneous information sources (visual and auditory in the classroom, and auditory from the BIE coach) that are in competition for the attention of the teacher. Their findings supported this approach, where shorter feedback prompts reduced cognitive load. Rock *et al.*, (2009) reported that participants could receive feedback and respond at the same time as giving instruction, which could contribute to a more significant cognitive load for the teacher. Scheeler *et al.*, (2010) employed a method to develop protocols associated with the feedback provided during BIE coaching, the teaching teams agreed on keywords and instructions that would not distract from the teaching and flow of the lesson, but would prompt a change or development in behaviour. Some participants had indicated that it was off-putting when receiving the feedback in situ (Owens *et al.*, 2020; Ploessl and Rock, 2014). However, participants also noted that it was distracting when receiving feedback remotely (Cooper *et al.*, 2018); therefore there is no clear correlation between the studies on teachers who responded well to the feedback and those who did not based on the type of prompt or location. It seemed to be due to personal preference; therefore, there should be an element of co-construction when developing short and succinct prompts for the teacher.

In understanding that cognitive load is a factor to consider when using BIE coaching, it is difficult to specify a quantity of prompts over a certain period without adding to the load on the

teacher. There was also no clear successful ratio of instructional time to delivering feedback prompts for any of the studies. Studies with shorter implementation sessions (5-15 minutes) often encouraged an item of BIE feedback once a minute (Coogle, Rahn, *et al.*, 2016; Cooper *et al.*, 2018; Randolph *et al.*, 2020), and longer studies did not set parameters (Rosenberg *et al.*, 2020; Scheeler *et al.*, 2010). There were no direct findings related to the concept of delivering feedback at specific times. An anecdotal finding from Scheeler and Lee (2002) was that the average number of immediate feedback phrases required for a change in teacher behaviour was low and similar for all participants. This could indicate that feedback should be applied every minute in shorter interventions of BIE coaching, and in interventions longer than 15 minutes, it would be applied where appropriate. There was also an indication that it depends on the type of skill being coached.

Strategies and impacts for teachers and learners

Overall, the use of BIE coaching to implement teaching strategies had a positive effect. In three studies BIE coaching was combined with other tools, such as video feedback (O'Brien *et al.*, 2021) and PLD (Randolph *et al.*, 2020) to enhance the target strategies. The TTC (three-term contingency) trials were the most common teaching strategy used in the interventions; however, this may be due to the size and type of groups that these studies worked with. In these trials the class size was small with 5 or 6 students (Randolph *et al.*, 2020) or one on one in the corridor (Scheeler *et al.*, 2012), where it was found that it was easier to administer BIE coaching with smaller groups (Scheeler *et al.*, 2006). The TTC trial aims to increase learners' correct responses, which is easier to control and measure in small groups. Where BIE coaching was used in larger groups (Rock *et al.*, 2009; Sharplin *et al.*, 2016; Stahl *et al.*, 2016) there were fewer specific strategies applied, or the strategies were defined by the individual teacher who set their own

goals (Sharplin *et al.*, 2016). This would indicate that if BIE coaching is intended to focus on specific strategies it would best be applied when the teacher is working with smaller groups. This would also concur with the work from Coninx (2013) who highlights the importance of reducing the cognitive load to improve the efficacy of the tool. When the teacher is working with larger groups it is important that they can set their own strategies and develop their own goals to meet these. “When it [coaching] is learner-centric and personalized it has the potential to address the aforementioned challenges [assist pre-service teachers to become confident, reflective practitioners, and learners of their own teaching practice] for teacher education” (Stahl *et al.*, 2016, p. 727).

It is important for teachers to notice and interpret classroom interactions in order to improve teaching (van Es and Sherin, 2002). BIE feedback is reliant on the coach to support the teacher in noticing. Subsequently a dependency on the coach to notice and interpret for the teacher may develop, mitigating long term improvement. However, where maintenance was measured, a positive change in practice was sustained post intervention (Garland and Dieker, 2019; McKinney and Vasquez, 2014; Owens *et al.*, 2020; Randolph *et al.*, 2020; Scheeler *et al.*, 2006). Here the importance of double loop feedback to re-examine responses to scenarios can support longer term change and development (Carless, 2019). For this reason, the reciprocal ongoing dialogic relationship between coach and teacher is important in establishing meaningful impact, aligning with the work from Lofthouse (2019) who highlights effective coaching develops through relational characteristics over time. Social validity questionnaires also indicated a positive sentiment toward BIE coaching from teachers (Coogle *et al.*, 2016; O’Brien *et al.*, 2021). It is also important to note that the coaching provided emotional support which could also lead to greater confidence (Stahl *et al.*, 2016).

There were positive effects on the learners involved in the BIE coaching interventions. These ranged from listening comprehension (Cheek *et al.*, 2019), behavioural outcomes (Coninx *et al.*, 2013; Owens *et al.*, 2020; Rock *et al.*, 2009), correct responses (Garland and Dieker, 2019; O'Brien *et al.*, 2021) and engagement (Cooper *et al.*, 2018). However, some studies measured no change in learner achievement, and there was evidence that BIE coaching was off-putting for students (Scheeler *et al.*, 2010). Scheeler *et al.*, (2010) also note that there was minimal discussion explaining the use of BIE coaching to the students in the teacher's classroom; where this was mentioned, it was left to the discretion of individual teachers. Scheeler *et al.*, (2010) state that the measurement of learner outcomes is the 'gold standard' of evaluating the effectiveness of any tool; therefore, there is room to expand on this domain in future studies.

Limitations

A more comprehensive search of all educational fields could have contributed to a more general overview of the range of practices in education, as several relevant sources were excluded as they were from ECE. The literature that focusses explicitly on feedback could inform how to provide synchronous BIE feedback. Grey literature was also excluded which has been known to cover useful guides and examples of practice.

Summary

This scoping review provides coaches and practitioners with a summary of research-based practice. There are a range of strategies that have the potential to be effective in varying contexts. Coaches implementing the tool should consider PLD based on the resources available. However, it is possible to train participants in a short amount of time. Coaches should deliver prompts within 3-5 seconds of an observed behaviour that are positive, corrective, questioning and goal orientated. The coach and teacher should work together to co-construct the prompts. In

coaching sessions under 15 minutes the coach should aim to provide feedback once a minute, and in longer sessions it should be applied where appropriate.

Specific strategies are best applied when the teacher is working with smaller groups, when the teacher is working with larger groups the coach should co-construct goals and strategies with the teacher for the most impact. The coach should also understand how cognitive load could be reduced to support the teacher. Overall, the literature has implications at a wider organisational level, indicating BIE coaching is a cost effective approach to teacher change that benefits both the learner and the teacher. PLD providers, universities and schools should understand that delivering coaching remotely yields the widest range of benefits; however using the latest technology still presents challenges. It is important for coaches to build on co-construction to establish an ongoing partnership between themselves and the teacher to enable long term development.

Through identifying gaps in the literature, there are opportunities to explore the coaching element in applying BIE coaching and how BIE feedback can differ from in-person feedback. The researchers will use the findings of this scoping review to conduct empirical research on new ways to deliver BIE coaching with a focus on understanding the qualities and relationships that enable an effective BIE coach.

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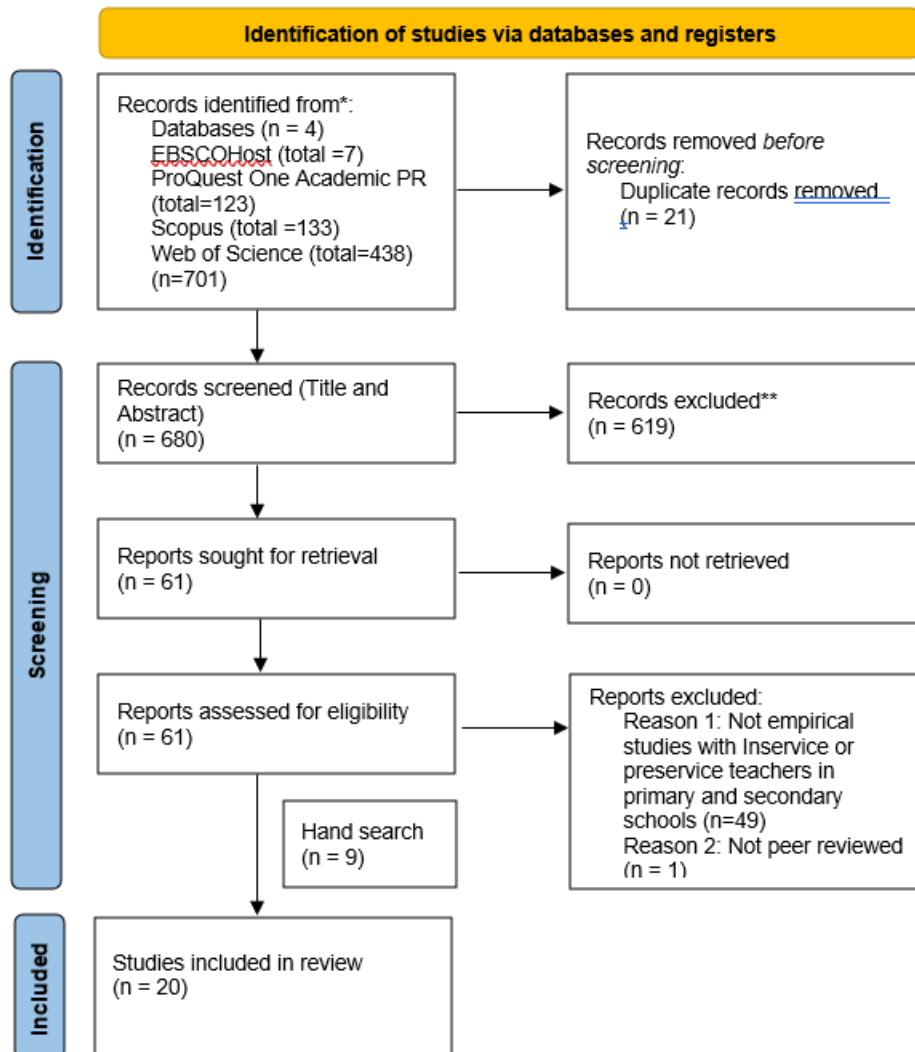
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Appendix A – Search terms example

Date	Search strategy	Database	Number of results	Field search
23/08/2021	(“Bug-in-ear” OR “bug in ear” OR BIE OR “technology assisted coaching” OR "tele-coaching" OR "eCoaching") AND (Coach* OR mentor*) AND (Student teacher OR associate teacher OR “pre-service teacher “) AND (“Kindergarten to grade 12” OR K-12 OR “primary school” OR “secondary school” OR “middle school” OR “senior school” OR “elementary education” OR “junior school”)	ProQuest One academic	123	Peer reviewed

Appendix B - PRISMA flow chart



Appendix C – Table of results

Author	Year	Title/Journal	Context	Study design	Communication/set-up	Evaluation
Cheek, A. E., M. L. Rock and B. A. Jimenez	2019	Online Module Plus eCoaching: The Effects on Special Education Teachers' Comprehension Instruction for Students with Significant Intellectual Disability <i>Education and Training in Autism and Developmental Disabilities</i>	SE, Private school 3x IST 3xStudents	MB	Webcam, MacBook Pro Laptop, Skype, Call recorder. 15minute PLD. 1:1, instruction, correction, clarifying.	eCoaching not distracting. Increased use of comprehension strategy.
Coninx, N., K. Kreijns and W. Jochems	2013	The use of keywords for delivering immediate performance feedback on teacher competence development <i>European Journal of Teacher Education</i>	GE 20x PST 20xCoaches	Control/experimental group	In-situ. Control had ad-hoc feedback delivered within 3 seconds. 58 keywords sent by computer.	Predetermined keywords reduced cognitive load.
Coogle, C. G., N. L. Rahn, J. R. Ottley and S. Storie	2016	ECoaching across routines to enhance teachers' use of modelling <i>Teacher Education and Special Education</i>	SE, 2x1st year IST	MB, SV.	6-minute intervention, one prompt per minute. Corrective or affirmative feedback.	Difficult to generalise how BIE worked with EBP.
Cooper, J. T., T. Whitney and A. S. Lingo	2018	Using Immediate Feedback to Increase Opportunities to Respond in a General Education Classroom <i>Rural special education quarterly</i>	GE elementary, 1x IST 1x Student (EBD/ADHD)	MB	Bluetooth headset, pre-recorded prompt.	BIE distracting at times. Must agree on the 'prompt.' Increased engagement for EBD and ADHD.
Garland, D. P. and L. A. Dieker	2019	Effects of Providing Individualized Clinical Coaching with Bug-in-Ear Technology to Novice Educators of Students with Emotional and Behavioral Disorders in Inclusive Secondary Science Classrooms <i>Journal of Inquiry and Action in Education</i>	GE, middle school, Science, 3x novice IST	MB	Adobe Connect, Bluetooth, short prompts.	Correct responses the TTC tests increased and maintained
Goodman, J. I., M. P. Brady, M. L. Duffy, J. Scott and N. E. Pollard	2008	The Effects of Bug-in-Ear" Supervision on Special Education Teachers' Delivery of Learn Units" <i>Focus on Autism and Other Developmental Disabilities</i>	SE, 3x novice IST	MB	In-situ. Motorola two-way radios T4500, earbud wired to a receiver. Long lead in with technology. List of prompts and feedback.	Positive effect on accuracy and rate of LU delivery.
McKinney, T. and E. Vasquez, III	2014	There's a Bug in Your Ear!: Using Technology to Increase the Accuracy of DTT Implementation <i>Education and Training in Autism and Developmental Disabilities</i>	SE elementary, 3xPST	MB	Two-way mirror. Brief encouraging or instructional feedback	Increase in discrete skill.
O'Brien, K. M., K. Regan, C. G. Coogle, J. R. Ottley and S. A. Nagro	2021	Impact of eCoaching With Video-Based Reflection on Special Education Teacher Candidates' Instructional Skills <i>Teacher Education and Special Education</i>	SE 3x IST	MB SV.	Remote, Swivl, iPad mini or MacBook, Google hangouts, screen recorded using Camtasia. 2hr PLD Co-constructed prompts: affirmative, corrective. Only provided in pauses. Video analysis.	Support use of EBPs and goal setting.
Owens, T. L., Y.-y. Lo and B. C. Collins	2020	Using Tiered Coaching and Bug-in-Ear Technology to Promote Teacher Implementation Fidelity <i>Journal of Special Education</i>	GE 4x IST, 4x students	Experimental design. SV	Initial PD followed by the three-tiered approach.	Positive effect to support student management
Ploessl, D. M. and M. L. Rock	2014	eCoaching: The Effects on Co-Teachers' Planning and Instruction <i>Teacher Education and Special Education</i>	SE, IST	MB SV	In-situ. Bluetooth headset, MacBook Pro © Skype, Call recorder. Reinforcement, positive, corrective and questioning feedback.	Partnership in inclusion classrooms, co-teaching effective. Minimal training slow development. Distracting at times.

Author	Year	Title/Journal	Context	Study design	Communication/set-up	Evaluation
Randolph, K. M., C. S. Chubb, B. L. Hott and E. Cruz-Torres	2020	iCoaching Behaviour-Specific Praise in a Rural Classroom <i>Rural Special Education Quarterly</i>	SE rural, elementary 1x IST 2x paraprofessionals 4x EBD learners.	MB. SV.	Swivl, iPod®, and a Bluetooth® earpiece. Zoom PLD module, guided notes, and post-test. Remote feedback within 3-5s of delivery.	Short PLD then immediate implementation not intrusive or time intensive.
Rock, M. L., M. Gregg, B. K. Thead, S. E. Acker, R. A. Gable and N. P. Zigmond	2009	Can You Hear Me Now?: Evaluation of an Online Wireless Technology to Provide Real-Time Feedback to Special Education Teachers-In-Training <i>Teacher education and special education</i>	General and SE K-12 master's level SE course. 15x IST	Mixed methods sequential explanatory strategy.	Webcam, Bluetooth USB adapter, Bluetooth headset, skype, 3 months to finetune technology. PLD article.	Increase rate of EBP. Increase on-task behaviour. Feedback same time as instruction, teachers.
Rock, M. L., N. Schoenfeld, N. Zigmond, R. A. Gable, M. Gregg, D. M. Ploessl and A. Salter	2013	Can You Skype Me Now? Developing Teachers' Classroom Management Practices Through Virtual Coaching <i>Beyond behaviour</i>	Masters level behaviour teaching course 28x IST	Revisit the previous Rock <i>et al.</i> 2009 study participants with interviews.	Bluetooth, webcam, Skype. Immediate and delayed feedback. 4:1 praise to correction ratio. Feedback was (a) instructing, (b) correcting, (c) encouraging, and (d) questioning.	Supports classroom management. Focus on strategies that are easy to implement.
Rosenberg, N. E., K. Artman-Meeker, E. Kelly and X. Yang	2020	The Effects of a Bug-in-Ear Coaching Package on Implementation of Incidental Teaching by Paraprofessionals in a K-12 School <i>Journal of Behavioral Education</i>	SE Private k-12 4x Paraprofessional/student dyads	MB SV.	Bluetooth earpiece, iPod® Touch, SWIVL Robot. 30+45min PLD. Feedback immediate, specific, constructive, and purposeful. Waited for pause. SWIVL not necessary.	Increases accuracy and rate EBP. Positive attitude towards BIE.
Scheeler, M. C., M. Congdon and S. Stansbery	2010	Providing Immediate Feedback to Co-Teachers Through Bug-in-Ear Technology: An Effective Method of Peer Coaching in Inclusion Classrooms <i>Teacher education and special education</i>	SE in GE 3x Dyads	MB. SV	Camera at back of classroom. PLD 30-45mins. Pre-determined feedback specific, positive, immediate, and corrective. Feedback 3 seconds after the incident.	Collaboration improves teaching skills, feedback offered support.
Scheeler, M. C. and D. L. Lee	2002	Using Technology to Deliver Immediate Corrective Feedback to Preservice Teachers <i>Journal of behavioural education</i>	SE K-12 3x PST	MB SV	In-situ. Wireless FM system. Immediate corrective verbal feedback. Short phrases, 1-3 seconds.	Corrective feedback successful.
Scheeler, M. C., J. K. McAfee, K. L. Ruhl and D. L. Lee	2006	Effects of Corrective Feedback Delivered via Wireless Technology on Preservice Teacher Performance and Student Behaviour <i>Teacher education and special education</i>	SE 5x PST	MB SV	In-situ. Wireless in ear. Immediate, corrective feedback. One- or two-word phrases within 3 seconds.	Immediate, corrective feedback successful.
Scheeler, M. C., K. McKinnon and J. Stout	2012	Effects of Immediate Feedback Delivered via Webcam and Bug-in-Ear Technology on Preservice Teacher Performance <i>Teacher education and special education</i>	SE 5x PST	MB SV	Laptop, Bluetooth earpiece. Skype. PLD 5 mins. Short phrases within 3 seconds.	Immediate, corrective remote feedback successful.
Sharplin, E. J., G. Stahl and B. Kehrwald	2016	'It's about improving my practice': the learner experience of real-time coaching <i>The Australian journal of teacher education</i>	GE 11x PST	Design-based research.	In-situ. Bluetooth headset. Expert practitioner providing feedback.	Improved professional practice, growth mindset and goal setting. Relieved stress.
Stahl, G., E. Sharplin and B. Kehrwald	2016	Developing pre-service teachers' confidence: real-time coaching in teacher education <i>Reflective practice</i>	GE 11x PST	Design based research.	Motorola CP476 CB Radio. Questioning to support reflection.	Increased confidence and resilience.

Key: SV=Social validity. GE=General Education SE=Special Education, MB=Multiple Baseline, Pre-service teachers = PST, In-service teachers=IST

